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MARX G E		
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McKENNA F G		
MONTROSE J K		
MORGAN R V		
POTTER G L		
PIZZUTO V M		
RISING T L		
SANDLING N B		
SCHWARTZ J K		
SETLOCK C H		
STEWART D L		
STIGER S G		
TOBIN P M		
WOODHEAD C M		
WILSON J M		
C A BICHER	✓	✓
B J CROCKER	✓	✓
E C HAST	✓	
M L KOCH	✓	
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RATS		

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EG&G ROCKY FLATS, INC
ROCKY FLATS PLANT P O BOX 464 GOLDEN COLORADO 80402 0464 (303) 966 7000

April 17, 1995

95-RF-03444 2 cy

BEST AVAILABLE COPY

Kurt Muenchow
Environmental Restoration Division
DOE, RFFO

OPERABLE UNIT (OU) 5, WOMAN CREEK PRIORITY DRAINAGE TECHNICAL MEMORANDUM #15, ADDENDUM TO THE FIELD SAMPLING PLAN WIND RESUSPENSION POTENTIAL STUDY REPORT, CAB-043-95

Action Transmit the results of the Wind Resuspension Potential Study to the Environmental Protection Agency (EPA) and the Colorado Department of Public Health and Environment (CDPHE)

This letter transmits four copies of the subject report for distribution to the EPA and the CDPHE The OU5 Wind Resuspension Potential Study was conducted in accordance with the Addendum to the Field Sampling Plan, TM #15 and the results are documented in the report The information contained in this report will be incorporated into the appropriate sections of the RFI/RI Report for OU5

If you have any questions regarding this transmittal please contact me at extension 9100

Carol A Bicher
Operable Unit No 5 Project Manager
Environmental Restoration Program Division

CAB:cb

Orig and 1 cc - K Muenchow

Attachment
As Stated

ADMIN RECORD

53203

OU5 WIND RESUSPENSION POTENTIAL STUDY

April 1995

EG&G Rocky Flats, Inc.
Golden, Colorado 80402-0464

Prepared by

Advanced Sciences, Inc.
405 Urban Street, Suite 401
Lakewood, Colorado 80228

EXECUTIVE SUMMARY

As part of the implementation of Technical Memorandum No 15 (TM15), Amended Field Sampling Plan, for the Operable Unit No 5 (OU5) RCRA Facility Investigation/Remedial Investigation (RFI/RI), an investigation into the wind resuspension potentials of soils in OU5 was conducted. The objective of this investigation was to assess the wind resuspension potential of the soils in the Individual Hazardous Substance Sites (IHSSs) in OU5 and to determine if the results of a wind tunnel study conducted previously throughout Operable Unit No 3 (OU3) could be used reliably for the OU5 RFI/RI air dispersion modeling and the Human Health Risk Assessment (HHRA) This investigation was conducted using the rapid assessment methodology described by Cowherd et al (1985) This investigation consisted of an examination of soil types and conditions and vegetative cover at selected locations within both OU5 and the OU3 wind-tunnel study area. The results of this investigation indicated that threshold friction velocities for the OU5 locations were consistently higher than the values reported in the OU3 wind tunnel study Therefore, the threshold wind speed values from the OU3 study can be applied to the air dispersion modeling for the OU5 RFI/RI and HHRA with the confidence that conservative, health-protecting assumptions are being exercised.

Introduction

The amended field sampling plan, Technical Memorandum No 15 (TM15), for the Woman Creek Priority Drainage Operable Unit No 5 (OU5) RCRA Facility Investigation/Remedial Investigation (RFI/RI) Work Plan (EG&G 1994a) described four air quality investigations the Radioactive Ambient Air Monitoring Program (RAAMP), special OU5 ambient air samplers, a wind resuspension potential study, and an examination of the volatilization of soil gases The RAAMP and OU5 samplers have continued operation as part of the routine air quality monitoring programs at the Rocky Flats Environment and Technology Site (RFETS) The amended RFI/RI Work Plan recommended the investigation into the volatilization of gases from OU5 only if inhalation of volatile chemical species was determined to be an exposure pathway of concern At this writing, the inhalation of volatile organic compounds by workers or future residents outdoors has not been designated a complete exposure pathway

This report discusses the supplemental field investigation into the wind resuspension potentials of the soils in OU5 that was conducted as part of the Addendum to Final Phase I RFI/RI Work Plan It presents the objectives, methods, and results of the study

Wind Resuspension Potential Study Objectives

Air dispersion modeling provides the primary basis for assessing the inhalation risks posed by windblown contaminated dust to current and future residents and future outdoor workers Perhaps the most critical input parameters to air dispersion models are those associated with the source terms In the situation of OU5, the important source input factors are the contaminant levels in the surface soils and the wind resuspension potentials of those soils The original investigations of the OU5 RFI/RI Work Plan focused on the contaminant levels in the surface soils and those findings are discussed extensively in TM15 The objective of the additional air quality study was to assess the wind resuspension potential of the soils in the Individual Hazardous Substance Sites (IHSSs) in OU5

In 1993, EG&G conducted a field investigation throughout Operable Unit No 3 (OU3) to determine the wind resuspension potentials of the soils in the areas east of Indiana Street (EG&G 1994b) The OU3 study utilized a portable wind tunnel. That study yielded important information about the wind erosion potential of the OU3 areas, possibly the most valuable of which was the calculation of specific threshold friction velocities and threshold wind speeds of the sites that were examined. Friction velocity, which is a measure of the wind shear at the erodible surface, characterizes the capacity of the wind to cause surface particle movement. Threshold friction velocity is the minimum velocity that results in particle movement. Threshold wind speed is equivalent wind speed at an elevation above the ground surface, for example, 10 meters which is the standard height of a reference anemometer The purpose of this wind resuspension potential study in the Woman Creek Drainage was to estimate the threshold friction velocities of the OU5 sites and compare these to the OU3 wind tunnel study results If the OU5 investigation results compare favorably with the threshold friction velocity values determined in the OU3 wind tunnel study, then the OU3 data can be utilized reliably for the OU5 RFI/RI air dispersion modeling and, henceforth, the Human Health Risk Assessment (HHRA)

Wind Resuspension Potential Study Methodology

The investigation of the wind erosion potential of contaminated soils in areas of interest in OU5, including IHSS 115, IHSS 133, the surface disturbance south of IHSS 133, IHSS 209, and the surface disturbance west of IHSS 209, was proposed as a phased approach The first phase involved a limited field investigation of the site and comparisons of these results with those of the more intensive wind tunnel study that was performed at OU3 If the first phase results were inconclusive, then a second phase was recommended. The second phase would be the replication at OU5 of the intensive field studies that were conducted in 1993 at OU3

The wind resuspension potential study relied on the rapid assessment methodology described by Cowherd et al. (1985) The field examinations consisted of observations about sites selected as representative of the areas of interest in both OU3 and OU5 (see Figures 1 through 5 for observation locations) At each location visual examinations of soil type and conditions and vegetative cover were conducted. The soil type was characterized along with the soil moisture and presence or absence of soil crusting. The extents of bare soil, vegetative cover, and other nonerodible elements (gravels and cobbles larger than 1 cm diameter) were estimated. Finally, a soil sieving procedure was conducted at each location with 4 mm, 2 mm, 1 mm, 0 5 mm, and 0 25 mm sieves to estimate the aggregate size mode of the surface soil From the estimate of the aggregate size mode, the threshold friction velocity of the soil was determined from a figure in the reference document. A correction factor was calculated to account for the increase in threshold friction velocity due to the nonerodible elements.

In working with the rapid assessment method, several limitations and difficulties with the procedures and calculations were encountered. The reference document (Cowherd et al , 1985) cautions that the procedures provide only a "first-cut, order-of-magnitude" estimate of exposure in limited applications Nevertheless, the Cowherd method is endorsed as affording a degree of accuracy consistent with simplified quantitative estimation procedures (EPA 1988) Approaches such as the Soil Conservation Service method (Woodruff and Siddoway 1965) to estimate wind erosion apply to annual losses from crop land and cannot be applied to generate short-term estimates The Cowherd method was selected because of the current land use of RFETS, the nature of the soils and vegetative cover in OU5, and the episodic high-wind events characteristic of the region

Certain assumptions incorporated into the rapid assessment method somewhat limited the interpretations of the OU5 study Most apparent was the utilization of only a few sieve sizes to estimate the mode of the aggregate size. Soil elements larger than 1 cm and smaller than 0 25 mm were not included in the sieve analysis At some locations, these fractions, more frequently the larger end of the scale, composed the most volumetric fraction. Standard soil sieving techniques quantify the fractions by weighings The Cowherd rapid assessment method calls for visual estimates of the relative sizes of the catches Investigators for this study improved the technique by volumetrically measuring the individual fractions to estimate the mode In addition, it was difficult to estimate how much of the nonerodible elements were embedded in the ground surface When in doubt, 50 percent seemed like a reasonable estimate. A serious limitation in the view of the investigators was the poor quantitative accounting for the mitigating effects of partial vegetative cover Correction factors for nonerodible elements could not be assigned values above 10 due to limitations in the graph accompanying the reference document.

Wind Resuspension Potential Study Results and Discussion

Field work was performed from January 20 to January 27, 1995 Weather conditions during the month prior to the field study were unusually dry All soils were dry during the study period. Ambient temperatures were unseasonably warm, in the 40 °F and 50 °F ranges Daytime winds during the study period were light from the southeast and east.

The 1993 OU3 wind tunnel study examined four terrestrial sites These same four terrestrial sites were investigated as part of this wind resuspension potential study (Figure 1) Sites T-1, T-2, and T-3 of the OU3 wind tunnel study were chosen for that study as representative of the soil and vegetation conditions on areas directly east of the Rocky Flats Plant. Conditions were somewhat different at each site At T-1, the soil was a clayey silt with some fine gravels, and vegetative cover was fair to good. Location T-3 was three-fourths of a mile or more east of T-1 Here the soil was a silty, sandy gravel. Although the vegetative cover was far less than at T-1, the other nonerodible elements provided a comparable overall coverage Location T-2 displayed a silty sand with fair vegetative cover The fourth terrestrial location, T-4, was about two miles southeast of the other three OU3 wind tunnel study sites It had been selected because it was characteristically different from the other three sites The soil was a silty sand, and although the aggregate size mode was comparable to two of the other OU3 sites, the vegetative and other nonerodible cover at this fourth location was minimal.

Ten locations, in two groups of five each, were chosen as representative of soil and vegetation conditions within IHSS 115 (Figure 2) Surface slopes throughout the landfill are fairly steep, 15 percent to 40 percent and facing south Locations 115AQ1 through 115AQ5 were situated west to east along the top of the landfill slope Soils were gravelly sands with larger aggregate size modes and noticeable bare soil. The extent of nonerodible elements, both gravels-cobbles and vegetation, was variable. Location 115AQ5 was somewhat down the slope and displayed a smaller aggregate size mode and more vegetative cover. The remaining locations in IHSS 115, 115AQ6 through 115AQ10, were situated east to west along the lower elevations of the landfill They were characterized generally by smaller aggregate size modes and very good vegetative cover

Within IHSS 133, five locations were examined as representative of conditions in that area of interest (Figure 3) Area slopes were gentle, approximately five percent with a south orientation Soils were gravelly sands and sandy silts with smaller aggregate size modes Vegetative cover was excellent, usually complete

At this writing, the three surface disturbance areas on the south side of Woman Creek are not considered areas of contaminant concern and have not included as radiological sources in the air dispersion modeling for the OU5 RFI/RI Fewer locations within these three areas were examined in this wind resuspension potential study

The surface disturbance south of IHSS 133 is located on a flat hilltop on the south side of Woman Creek. Within this area, two locations, identified as SASH-AQ16 and SASH-AQ17, were investigated (Figure 4) Soils were gravelly sands indicative of a hilltop situation The aggregate size modes were smaller Vegetative cover was very good.

IHSS 209 is a large, basically level, surface disturbance area on another hilltop on the south side of Woman Creek Three locations, identified as 209AQ18 through 209AQ20, within IHSS 209 were examined (Figure 5) The soils on this hilltop were generally sandy gravels exhibiting larger aggregate modes Vegetative cover was only fair, but other nonerodible elements added conspicuous protection from wind erosion

The surface disturbance west of IHSS 209 is a moderately sloping hillside, north-facing, on the south side of Woman Creek Two locations, W209AQ21 and W209AQ22, were examined in this homogeneous area (Figure 5) Gravelly and clayey sands characterized the slope Aggregate size modes were smaller Vegetative cover was uniformly very good.

The results of the OU5 wind resuspension potential study are summarized in Table 1 The rapid assessment method produced values for threshold friction velocities at the four OU3 wind tunnel study sites that were within the same order of magnitude, but higher by several factors, as the results of the OU3 wind tunnel study (Table 2) Field observations of the vegetative and soil conditions at both the OU3 wind tunnel study sites and throughout OU5 found that the two areas generally were comparable Soil particle aggregate size modes were typically larger throughout OU5 The vegetative cover was generally more extensive in OU5 than in OU3, excepting the top of the landfill slope and IHSS 209

The threshold friction velocities calculated for the OU5 locations were consistently higher, sometimes by an order of magnitude, than the values reported in the OU3 wind tunnel study Consequently, the threshold wind speed values from the OU3 study can be applied to the air dispersion modeling for the OU5 RFI/RI and HHRA with the confidence that conservative, health-protecting assumptions are being exercised.

The rapid assessment method yielded values that are conservative estimates of the threshold friction velocities and threshold wind speeds around OU5 With the availability of the results of the wind tunnel study at OU3, where field conditions are generally comparable to OU5, more accurate values are not required at this time for air dispersion modeling purposes It is recommended, however, that a more thorough analysis of the general applicability of the OU3 wind tunnel study results to sites all around the Rocky Flats Plant be designed and implemented.

Table 1 OU5 Wind Resuspension Potential Study Results

Location	Aggregate size mode estimate (mm)	Threshold friction velocity u*t *uncorrected (cm/s)* (Fig 3-4) (1)	Bare soil (m^2) (2)	Vegetation coverage (m^2) (2 3)	Other nonerodible coverage (m^2) (2,3)	Vertical fraction embedded	Equivalent frontal area of nonerod elements (m^2) [Coverage (1-emb frac)]	Lc [Eq front area/ Area of bare soil]	Correction ratio (Fig 3-5) (1 4)	Threshold friction velocity u t corrected (cm/s) [(u*t)(Ratio)]	Equivalent 10-m wind speed *(mi/hr)* (5)
115AQ1	4	115	0 3	0 35	0 65	0 35	0 4225	1 4	10	1150	418
115AQ2	3	100	0 6	0 15	0 25	0 5	0 125	0 2	10	1000	364
115AQ3	4	115	0 4	0 35	0 25	0 5	0 125	0 3	10	1150	418
115AQ4	4	115	0 2	0 05	0 8	0 5	0 4	2 0	10	1150	418
115AQ5	1 5	75	0 15	0 8	0 25	0 5	0 125	0 8	10	750	273
115AQ6	0 5	50	0 1	0 9	0 1	0 75	0 025	0 3	10	500	182
115AQ7	0 75	58	0 55	0 4	0 15	0 5	0 075	0 1	7	406	148
115AQ8	4	115	0 1	0 9	0 65	0 5	0 325	3 3	10	1150	418
115AQ9	1 5	75	0 05	0 95	0 15	0 5	0 075	1 5	10	750	273
115AQ10	0 75	58	0 05	0 95	0 03	0 5	0 015	0 3	10	580	211
133AQ11	3	100	0 05	0 95	0 25	0 75	0 0625	1 3	10	1000	364
133AQ12	1 5	75	0	1	0 05	0 5	0 025	#DIV/0!	infinite	infinite	infinite
133AQ13	1	65	0 25	0 75	0 1	0 5	0 05	0 2	10	650	236
133AQ14	4	115	0	1	0 7	0 5	0 35	#DIV/0!	infinite	infinite	infinite
133AQ15	0 75	58	0	1	0 3	0 8	0 06	#DIV/0!	infinite	infinite	infinite
SASH-AQ16	0 75	58	0 2	0 8	0 3	0 5	0 15	0 8	10	580	211
SASH AQ17	0 3	40	0 03	0 97	0 3	0 5	0 15	5 0	10	400	145
209AQ18	4	115	0 25	0 4	0 4	0 5	0 2	0 8	10	1150	418
209AQ19	4	115	0 2	0 3	0 5	0 5	0 25	1 3	10	1150	418
209AQ20	4	115	0 1	0 5	0 65	0 8	0 13	1 3	10	1150	418
W209AQ21	0 5	50	0 1	0 9	0 15	0 5	0 075	0 8	10	500	182
W209AQ22	0 75	58	0 1	0 9	0 025	0 5	0 0125	0 1	7	406	148
OU3T 1AQ23	0 3	40	0 25	0 7	0 05	0 25	0 0375	0 2	10	400	145
OU31 2AQ25	0 5	50	0 35	0 6	0 15	0 2	0 12	0 3	10	500	182
OU3T 3AQ24	2	88	0 05	0 25	0 7	0 5	0 35	7 0	10	880	320
OU3T 4AQ26	0 5	50	0 85	0 1	0 1	0 5	0 05	0 1	7	350	127

Notes

(1) *Figure references are from* Cowherd et al 1985

(2) Estimates are based on examinations of 1 m^2 of ground at selected locations

(3) Sum of vegetation coverage plus other nonerodible elements coverage *may be more than* (1 Bare soil) due to overlap of vegetation and other nonerodible elements

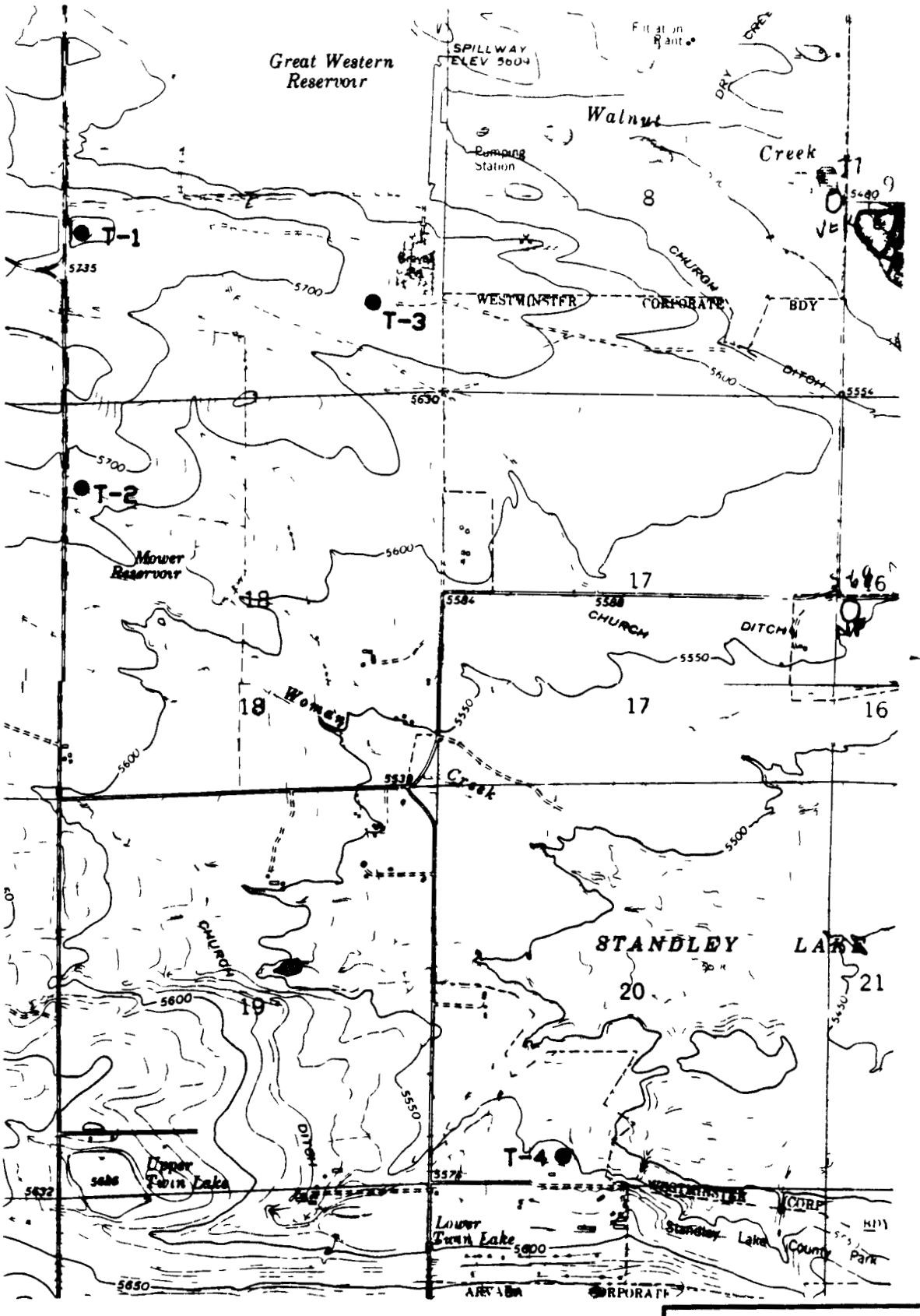
(4) *Maximum correction ratio extrapolated from* Figure 3 5 is 10 which is used for all Lc values >0 1

(5) Equivalent 10-m wind speed is calculated from the threshold friction velocity using the logarithmic wind profile distribution u(z) = (u*t/0 04)(ln z/zo) where the roughness height zo is assumed to be 1 5 cm facility wide

Table 2. Comparison of Results of 1993 Wind Tunnel Study and 1995 Rapid Assessment Method

OU3 location	Threshold friction velocity (cm/s)	
	1993 Wind tunnel study (1)	1995 Rapid assessment method
T-1	>280	400
T-2	>170	500
T-3	>180	880
T-4	>160	350

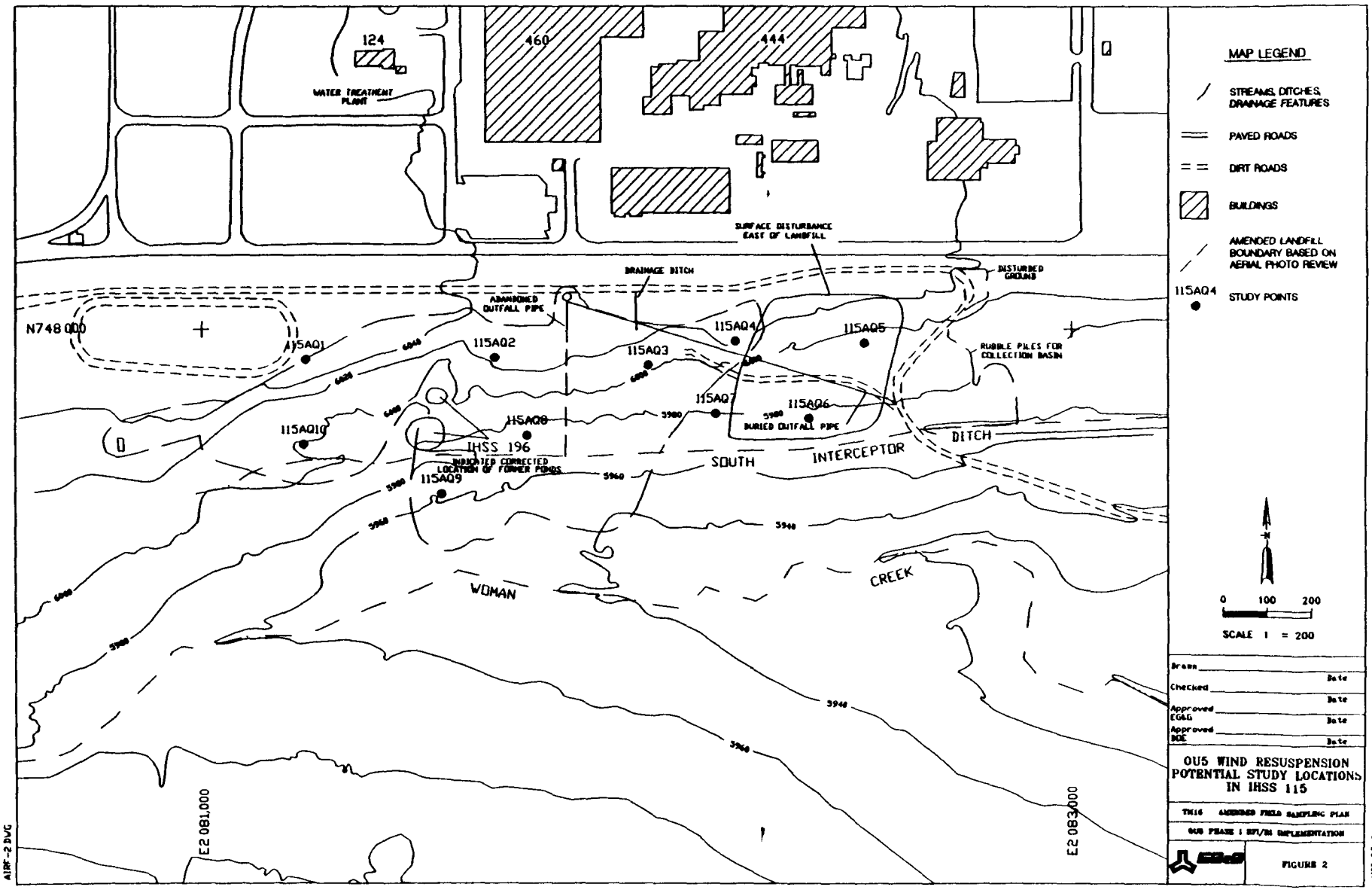
Note (1) EG&G 1994

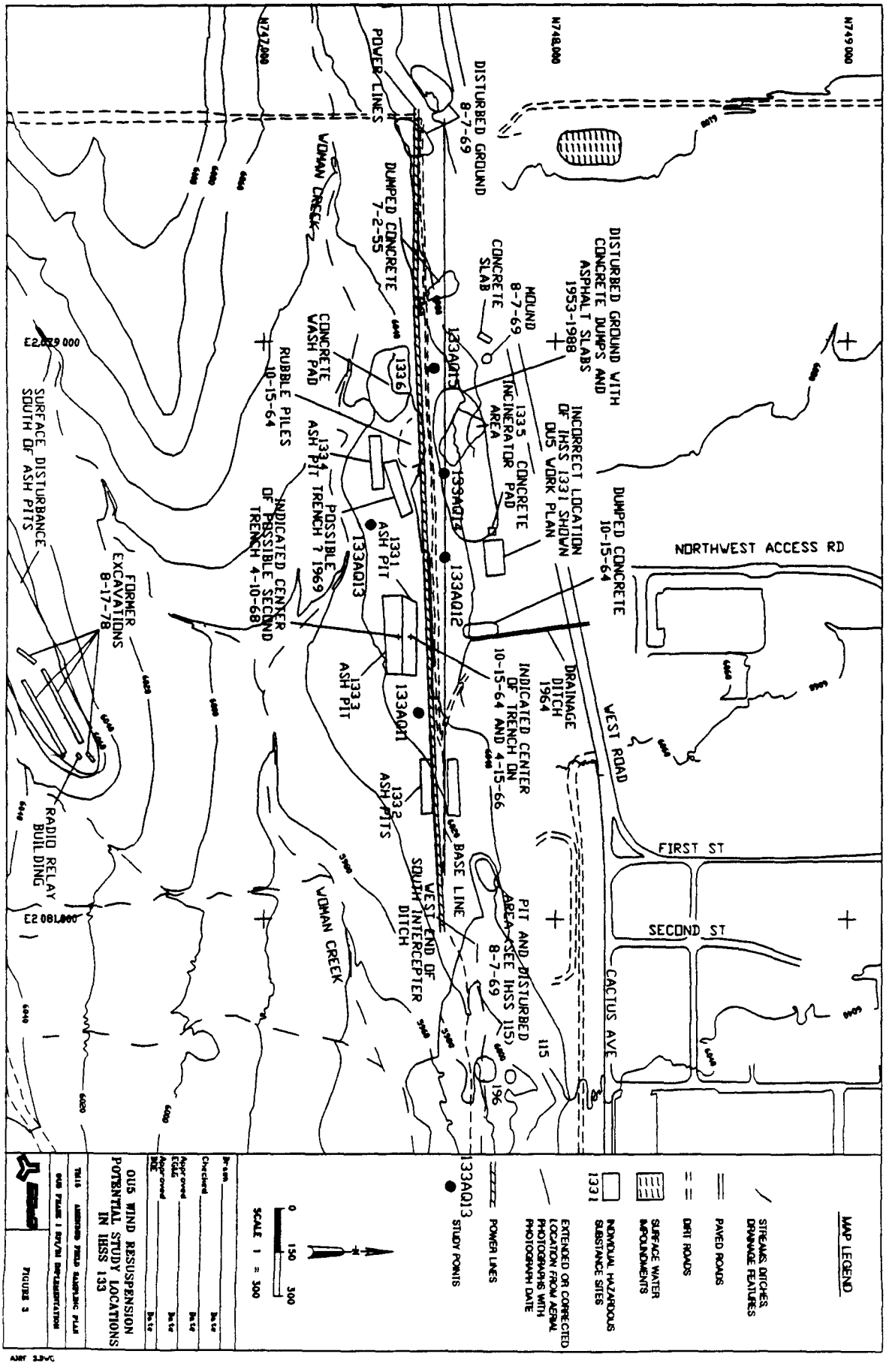


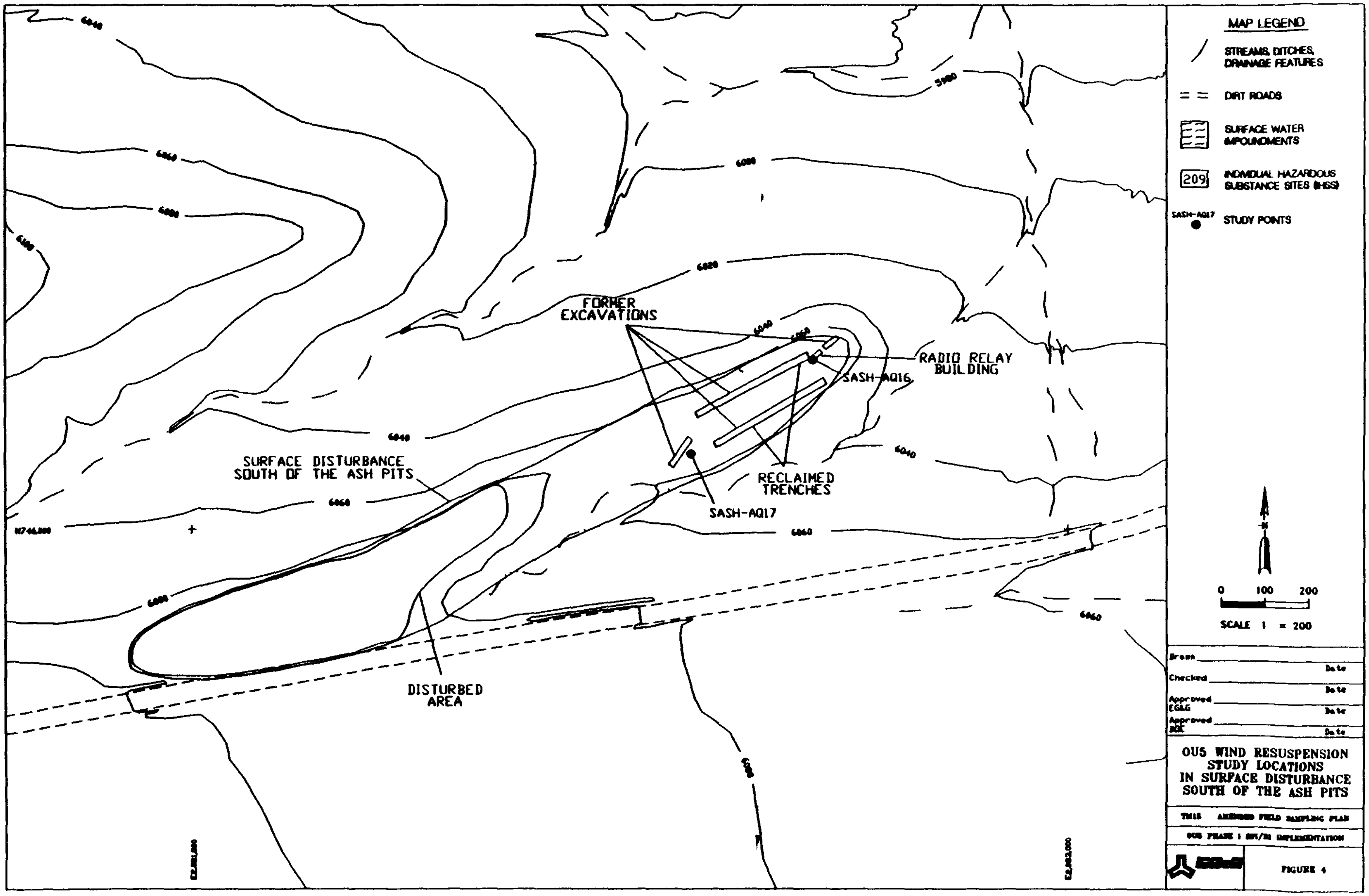
1993 OU3 WIND TUNNEL STUDY
TERRESTRIAL SAMPLING SITES

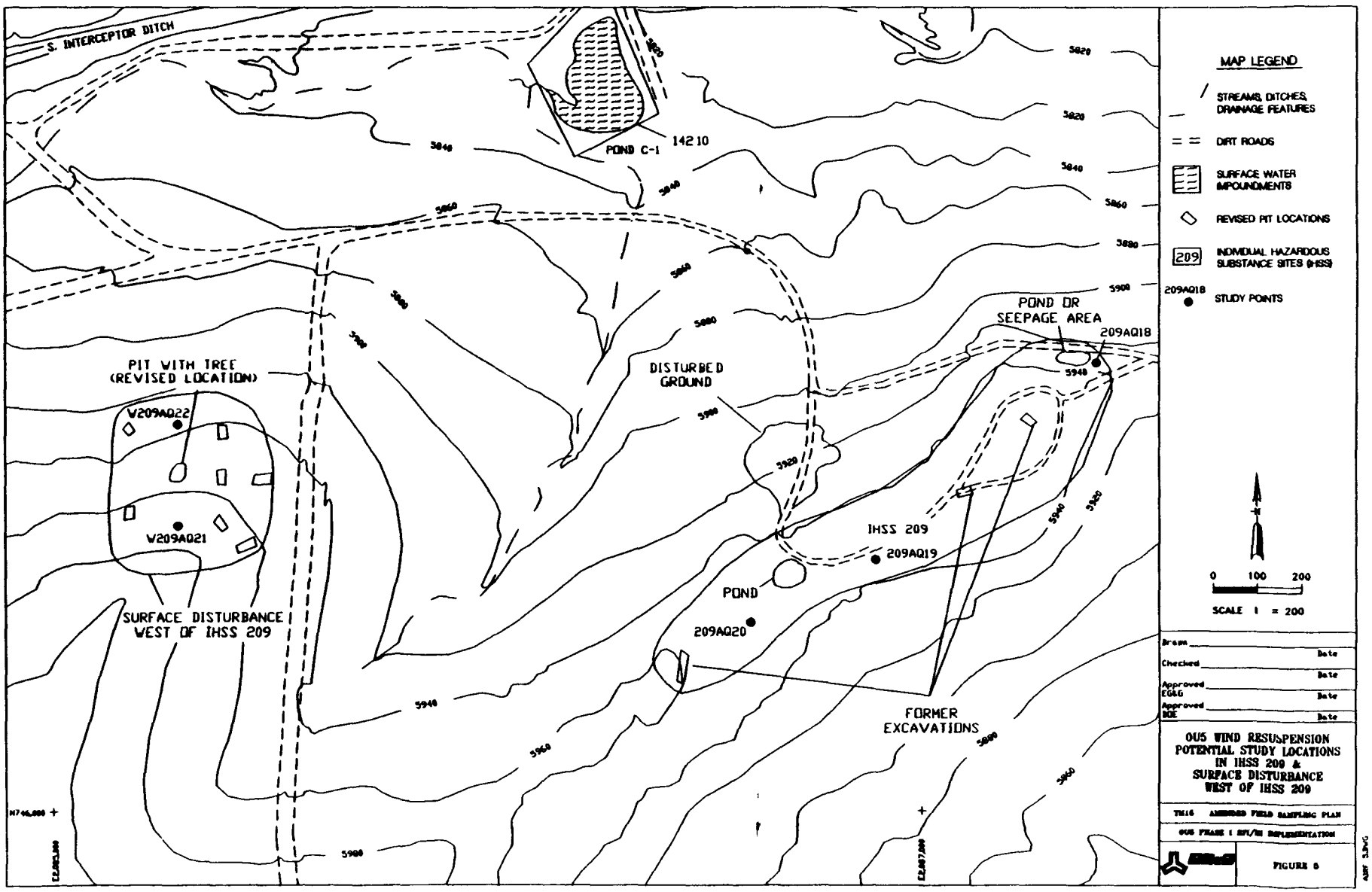
FIGURE 1

AIRF 1.DVG


124
460
444
WATER TREATMENT PLANT
SURFACE DISTURBANCE EAST OF LANDFILL
DRAINAGE DITCH
DISTURBED GROUND
ABANDONED OUTFALL PIPE
N748 000
115AQ1
115AQ2
115AQ3
115AQ4
115AQ5
RUBBLE PILES FOR COLLECTION BASIN
115AQ7
115AQ6
BURIED OUTFALL PIPE
115AQ10
115AQ8
IHSS 196
INDICATED CORRECTED LOCATION OF FORMER PONDS
115AQ9
SOUTH
INTERCEPTOR
DITCH
WOMAN
CREEK
E2 081,000
E2 083,000
MAP LEGEND
STREAMS, DITCHES, DRAINAGE FEATURES
PAVED ROADS
DIRT ROADS
BUILDINGS
AMENDED LANDFILL BOUNDARY BASED ON AERIAL PHOTO REVIEW
115AQ4 STUDY POINTS
N
0 100 200
SCALE 1 = 200
Drawn
Checked
Approved EG&G
Approved DOE
Date
OU5 WIND RESUSPENSION POTENTIAL STUDY LOCATIONS IN IHSS 115
THIS AMENDED FIELD SAMPLING PLAN
OU5 PHASE I RFI/RI IMPLEMENTATION
FIGURE 2


N749000
N748000
N747000
E2079000
E2081000
DISTURBED GROUND 8-7-69
POWER LINES
DUMPED CONCRETE 7-2-55
WOMAN CREEK
CONCRETE SLAB
MOUND 8-7-69
DISTURBED GROUND WITH CONCRETE DUMPS AND ASPHALT SLABS 1953-1988
INCORRECT LOCATION OF IHSS 133 SHOWN ON WORK PLAN
1335 CONCRETE PAD INCINERATOR AREA
133AQ14
133AQ15
1336
CONCRETE WASH PAD
RUBBLE PILES 10-15-64
1334 ASH PIT
POSSIBLE TRENCH 7 1969
INDICATED CENTER OF POSSIBLE SECOND TRENCH 4-10-68
133AQ13
1331 ASH PIT
133AQ12
DUMPED CONCRETE 10-15-64
NORTHWEST ACCESS RD
DRAINAGE DITCH 1964
INDICATED CENTER OF TRENCH ON 10-15-64 AND 4-15-66
133AQ11
1333 ASH PIT
1332 ASH PITS
WEST END OF SOUTH INTERCEPTER DITCH
BASE LINE
PIT AND DISTURBED AREA (SEE IHSS 115) 8-7-69
115
196
133AQ13
WEST ROAD
FIRST ST
SECOND ST
CACTUS AVE
SURFACE DISTURBANCE SOUTH OF ASH PITS
FORMER EXCAVATIONS 8-17-78
RADIO RELAY BUILDING
MAP LEGEND
STREAMS, DITCHES, DRAINAGE FEATURES
PAVED ROADS
DIRT ROADS
SURFACE WATER IMPOUNDMENTS
INDIVIDUAL HAZARDOUS SUBSTANCE SITES
1331
EXTENDED OR CORRECTED LOCATION FROM AERIAL PHOTOGRAPHS WITH PHOTOGRAPH DATE
POWER LINES
133AQ13 STUDY POINTS
0 150 300
SCALE 1 = 300
OU5 WIND RESUSPENSION POTENTIAL STUDY LOCATIONS IN IHSS 133
FIGURE 3


FORMER EXCAVATIONS
RADIO RELAY BUILDING
SASH-AQ16
SASH-AQ17
RECLAIMED TRENCHES
SURFACE DISTURBANCE SOUTH OF THE ASH PITS
DISTURBED AREA
6040
6060
6080
6020
5980
MAP LEGEND
STREAMS, DITCHES, DRAINAGE FEATURES
DIRT ROADS
SURFACE WATER IMPOUNDMENTS
209 INDIVIDUAL HAZARDOUS SUBSTANCE SITES (IHSS)
SASH-AQ17 STUDY POINTS
N
0 100 200
SCALE 1 = 200
Drawn Date
Checked Date
Approved EG&G Date
Approved DOE Date
OU5 WIND RESUSPENSION STUDY LOCATIONS IN SURFACE DISTURBANCE SOUTH OF THE ASH PITS
FIGURE 4


S. INTERCEPTOR DITCH
POND C-1
14210
PIT WITH TREE
(REVISED LOCATION)
W209AQ22
W209AQ21
SURFACE DISTURBANCE
WEST OF IHSS 209
DISTURBED
GROUND
POND OR
SEEPAGE AREA
209AQ18
IHSS 209
209AQ19
POND
209AQ20
FORMER
EXCAVATIONS
MAP LEGEND
STREAMS, DITCHES, DRAINAGE FEATURES
DIRT ROADS
SURFACE WATER IMPOUNDMENTS
REVISED PIT LOCATIONS
209
INDIVIDUAL HAZARDOUS SUBSTANCE SITES (IHSS)
209AQ18
STUDY POINTS
0 100 200
SCALE 1 = 200
Drawn
Checked
Approved EG&G
Approved DOE
Date
OU5 WIND RESUSPENSION POTENTIAL STUDY LOCATIONS IN IHSS 209 & SURFACE DISTURBANCE WEST OF IHSS 209
TM16 AMENDED FIELD SAMPLING PLAN
OU5 PHASE I RFI/RI IMPLEMENTATION
FIGURE 5

References

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EG&G 1994a. *Draft Final Technical Memorandum No 15 Addendum to Final Phase I RFI/RI Work Plan, Amended Field Sampling Plan Volume 1 Rocky Flats Plant Woman Creek Priority Drainage (Operable Unit No 5)* Golden, CO EG&G Rocky Flats, Inc

EG&G 1994b *OU3 Wind Tunnel Study Volume I Test Report* Prepared by Midwest Research Institute under DOE Prime Contract No DE-AC04-90DP62349, Subcontract No ASC218973GG, MRI Project No 3155-M, January 24, 1994 Golden, CO EG&G Rocky Flats, Inc

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Woodruff, N P and F H. Siddoway 1965 A wind erosion equation. *Soil Science of America Proceedings* 29 (5) 602-608